AGILE WAVEFORM GENERATION & FREQUENCY CONVERSION

HRL LABORATORIES
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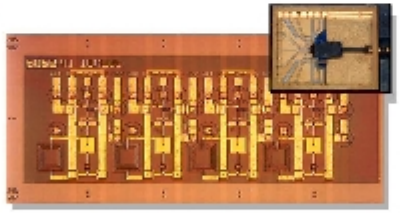
RF-LIGHTWAVE TECHNOLOGY FOR MILITARY SYSTEMS

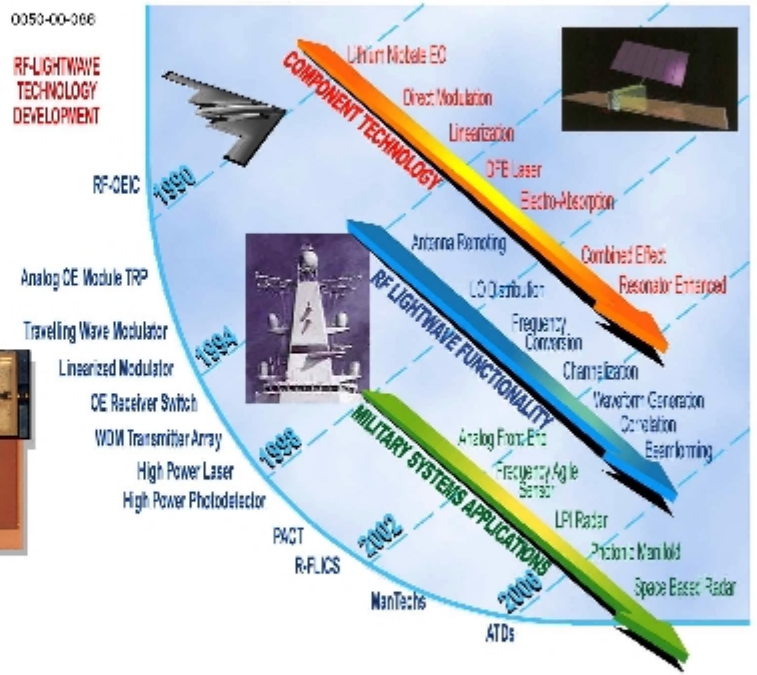
PHOTONIC STEERED ANTENNA

TRUE-TIME DELAY RADAR TESTER

WDM TRANSMITTER

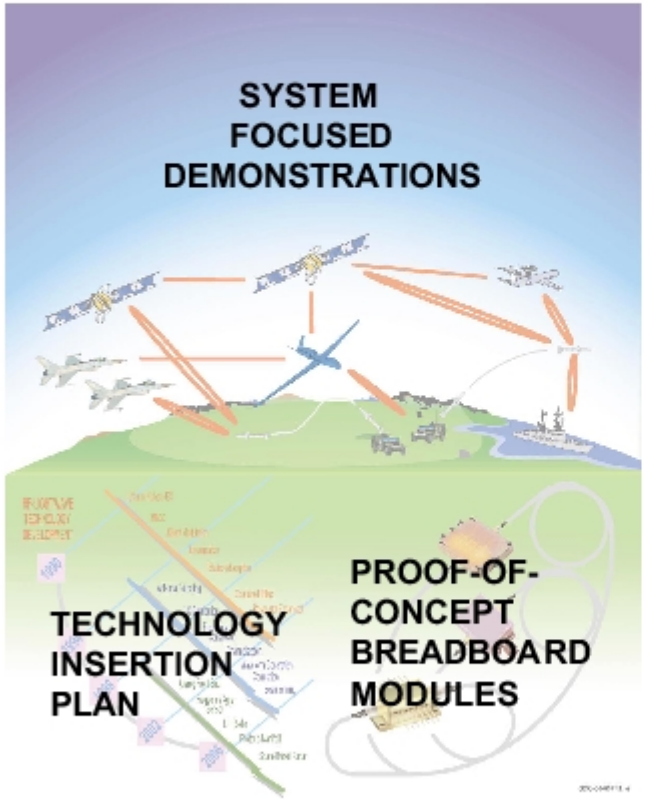


OEIC RECEIVER



- HRL and its owners are leaders in the innovation of RF, lightwave and combined RF-lightwave technologies for military systems.
- HRL has the potential for early-to-system incorporation of advances in RF-lightwave technology.

TECHNOLOGY DEVELOPMENT APPROACH



AGILE WAVEFORM GENERATION and FREQUENCY CONVERSION

OPTICAL LOCAL OSCILLATORS	FREQUENCY SPREAD WAVEFORMS
NARROW-LINEWIDTH LASERS	HIGH-EFFICIENCY MODULATORS

HRL LABORATORIES · SARNOFF Corporation · UCSD · Raytheon

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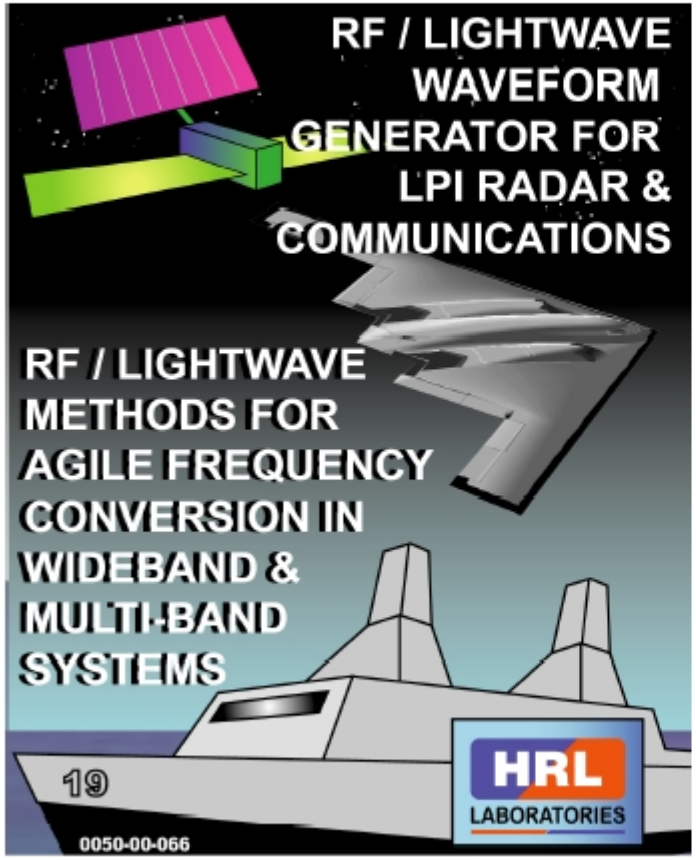
TECHNICAL OBJECTIVES AND APPLICATIONS



BENEFITS & APPLICATIONS

- Reduced Probability of Interception
- Reduced Interference in RF Communication Networks
- Stealth Platforms
- Cooperative Multi-Platform Sensors

- Rapid Frequency Translation
- Efficient Re-use of Waveform Synthesizers and Processors
- Large Multi-band Frequency Coverage
- Integrated Sensor Systems
- Frequency Agile Front Ends
- Multi-band Communications
- Ultra-Wideband Sensors

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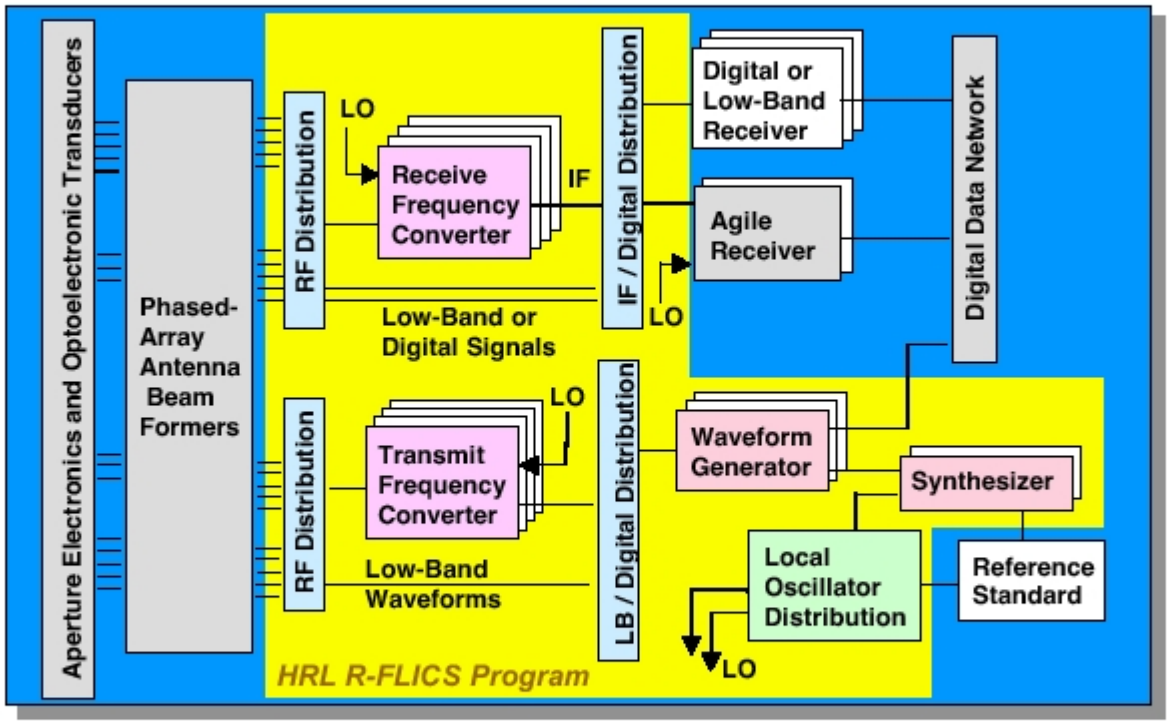
PHOTONIC TECHNOLOGY IN MULTI-BAND RF SENSOR MANIFOLDS



- Optical Fiber Networks Can Distribute Combination of μWave, mmWave, UHF, LO, Digital Signals
- Photonic Technology Enables a Complete Redesign of the RF Sensor Front-End Accompanied by Improvements in Bandwidth and Frequency Agility Plus Reduction of Size/Weight

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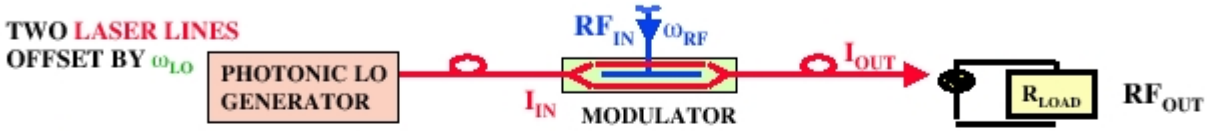
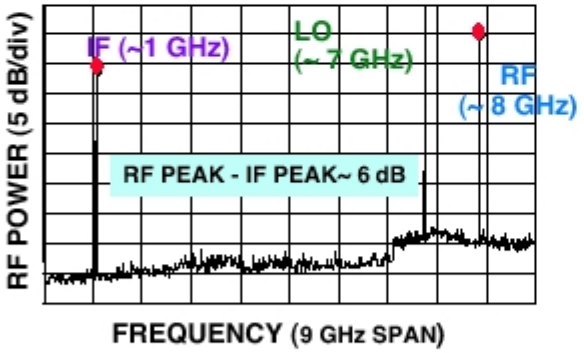
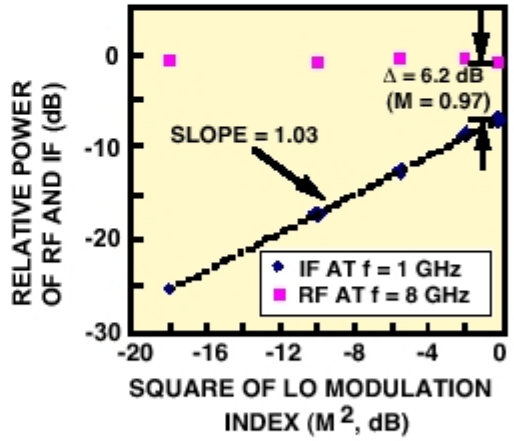
CONVERSION EFFICIENCY ACHIEVED WITH PHOTONIC LO GENERATION AND FREQUENCY CONVERSION



Photocurrent (i_d): $$i_D = \frac{\alpha I_0}{2L_{MOD}}\left\{1 + m\sin(\omega_{RF}t) + M\cos(\omega_{LO}t + \phi) \pm \frac{1}{2}mM\sin\left[(\omega_{LO} \pm \omega_{RF})t + \phi\right]\right\}$$





- Frequency Conversion Loss of - 6.2 dB was Achieved When Lasers were Set for M = 0.97 if Photonic Link Gain is 0 dB

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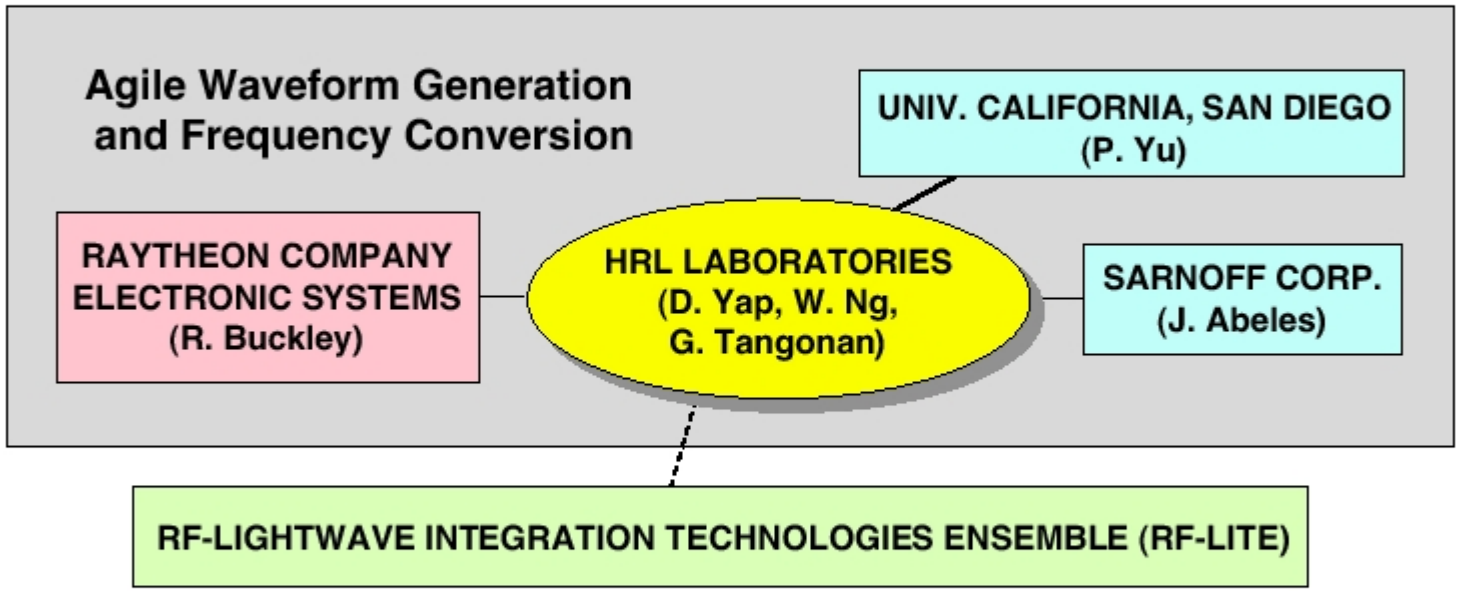
ORGANIZATION AND POINTS OF CONTACT



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RF-LIGHTWAVE INTEGRATION TECHNOLOGIES ENSEMBLE (RF-LITE)

- ROLE OF HRL & RAYTHEON:
  - Provide military-systems application focus for component development
  - Generate system derived RF-lightwave link specifications
  - Provide showcase for RFLICS components by means of a system-focused demonstration event
- ROLE OF COMPONENT-DEVELOPMENT TEAMS:
  - Provide (on a non-exclusive, voluntary basis) components to be inserted into demonstration
  - Provide input on component capabilities for RFLICS technology insertion

ENSEMBLE MEMBERS	RELEVANT COMPONENTS
• Photonic Systems (C. Cox, R. Ram, J. Abeles, R. Osgood)	Wideband, Low-Voltage Modulator High Slope Efficiency Laser
• Sarnoff (J. Abeles)	Low-Voltage Modulator
• UCSB (J. Bowers, L. Coldren)	High-Efficiency and Linearity Laser Wideband Modulator High-Sensitivity Photoreceiver
• USC (D. Dapkus)	Low-Voltage Modulator

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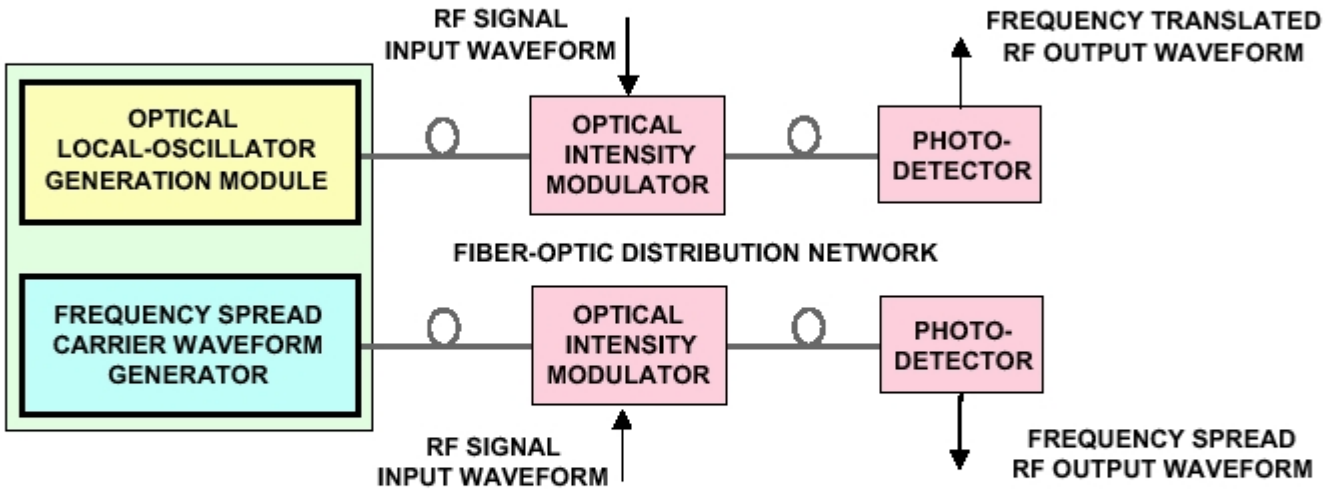
DEMONSTRATION OF AGILE WAVEFORM GENERATION AND FREQUENCY CONVERSION



- Agile Frequency Translation To Various RF Tx/Rx Bands
- Compare With Photonic Links Modulated At RF Carrier Frequency
- Agile Frequency Spreading of RF Signal Within a Band
- Compare With Single-Tone RF Carriers For Tx/Rx

Most of the RFLICS component types could be incorporated into this system-focused demonstration.

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MAJOR PROJECT TASKS AND SCHEDULE